F-91

OPERATING INSTRUCTIONS

MODEL TTS 26B
PULSE SIGNALING TEST SET

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MODEL TTS 26B PULSE SIGNALING TEST

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MODEL TTS 26B PULSE SIGNALING TEST SET

OPERATING INSTRUCTIONS

1.0 GENERAL

1.01 The Model TTS 26B is a compact pulse signaling test set designed to send pulses generated by either a built in transistorized oscillator or by an external source, and to measure the speed and % break of the transmitted pulses or of pulses received from external circuits. The % break of the puses transmitted by the instrument can be varied over a wide range. The speed of these pulses can be varied in seven discrete steps.

1.02 Signals can be received or transmitted on a loop or E&M basis. Connections with the circuits to be tested are made through a series of jacks. Several switches permit the operator to set up circuits for different combinations of sending and receiving on either loop or E&M, or combinations of both. The simplified schematics of the measure and send circuits, the dial or talk circuits, and the supervisory monitor circuits in the set are shown in Figs. 1, 2, and 3.

1.03 The Model TTS 26B may be used as a pulse repeater or converter. Signals from an external circuit may be applied to the EXT DIAL terminals or jack and used to operate the internal pulsing relay. The % break of this signal can be varied and it can be retransmitted on a loop or E&M basis or it can be used to control external circuits such as voice frequency signaling circuits, polar duplex circuits, etc.

1.04. Measurements may be made by connecting the high impedance meter circuit to the circuit under test, either directly or through a low impedance "slave" relay. The meter slave relay is particularly useful when testing circuits with high capacity or inductance which might distort the pulse wave shape and thereby result in erroneous meter readings if the high impedance meter were used directly on the circuit under test.

1.05 The meter has two scales - one for measuring % break and the other for pulse speed measurements in pulses per second (PPS). The single scale for measuring % break is obtained by switching the meter circuit to correspond to the selected mode of operation.

1.06 The Model TTS 26B may be operated in any position.

1.07 Normally, the instrument is operated from the 48-volt central office battery. Its maximum current drain is 220 ma and an internal 1A fuse is provided. In emergencies a heavy duty 45-volt dry battery will operate the instrument for a short period of time.

1.08 The set is contained in an aluminum carrying case with a removable hinged cover which includes a storage compartment

for cords, small tools, and other items.

1.09 Accessory covers are available to provide additional functions which increase the versatility of the Model TTS 26B. These can be substituted for the removable hinged cover which is normally supplied with the set. A separate description of each cover is supplied as supplementary information.

2.0 PERFORMANCE AND SPECIFICATIONS

2.01 Meter - A 4 1/2" meter with two scales is provided. The % break scale is calibrated from 0 to 100% in 1% divisions. The PPS scale is calibrated from 0 to 25 pps in 1 pps divisions. Damping circuits permit proper reading of the "standard" % break when the digit 0 is dialed on a 10 cps dial; they also reduce pointer vibration to about ±1 division on 10 pps signals.

2.02 Impedance of Measuring Circuit

For % Break Measurements

Meter circuit: approximately 7500 ohms
Meter relay: approximately 400 ohms

For Speed Measurements: approximately 4300 ohms

2.03 Send Signals - 4, 6, 8, 10, 12, 14, 20 Pulses/Sec. One additional frequency can be installed on special order. An external dial may also be used to generate pulses.

2.04 Send % Break Range - At least 12% to 85% when using the internal oscillator. Approximately the same limits apply when using a dial as a source of pulses.

2.05 Calibration - An adjustable calibration control permits operation of the set on battery voltages from approximately 40 to 55 volts and eliminates the need to apply correction factors for different battery voltages.

2.06 Power Requirements - 48 volts dc, 220 ma. A diode protects the internal circuits against damage in the event the battery polarity is reversed. Operation at 24 volts dc can be supplied on special order.

2.07 Size and Weight - Dimensions of the case and cover are 14" w x 10" h x 8" d; weight is 15 pounds.

3.0 CONTROLS AND JACKS

3.01 The following controls are included in the TTS 26B:

1. ADJ % BREAK Control - Provides means for setting the % break of the transmitted pulses from the oscillator or the external dial.

2. Meter Calibration Control - METER CAL - Provides full scale calibrating of the meter for different supply voltages or for external circuits with different resistances.

3. PULSES PER SEC Switch - Provides the following functions:

   a. Switches the power on or off.
   b. Switches the pulse rate of the internal oscillator.

4. FUNCTION Switch - Provides the following functions in clockwise sequence:

   a. SND - ON HOOK
   b. SND - OFF HOOK
   c. SEND AND REC
   d. CAL - ADJ % BREAK
   e. CAL - CAL METER

5. RECEIVE Switch - Provides the following modes of operation in clockwise sequence:

   a. REC B&G ON LOOP
   b. REC LOOP
   c. REC B&O (M)
   d. REC B&G (M)
   e. REC G&O (E)
   f. The final clockwise position permits the SEND switch to control both SEND and RECEIVE functions as shown in 7 below.

6. SEND Switch - Provides the following modes of operation in clockwise sequence when RECEIVE switch is in positions a through e:

   a. SND LOOP (See Note)
   b. SND LOOP (See Note)
   c. LINE (B&G on M)
   d. DROP (G&O on E)
   e. LINE (B&O on M)
   f. DROP (G&O on E)

   NOTE: The two SND LOOP conditions are identical; only the receive functions are changed when this switch is used to connect both the send and receive functions as described in 7a and 7b.

7. The SEND switch (when control also is provided for the receiving mode of operation simultaneously, i.e., with the RECEIVE switch in extreme clockwise position) provides the following combined send and receive modes of operation in clockwise sequence when RECEIVE switch is in position (full clockwise):

    a. SND LOOP, REC B&G (on loop)
    b. SND LOOP, REC LOOP (for dry loop)
    c. E&M-LINE (Send B&G on M, Receive G&O on E)
    d. E&M-DROP (Send G&O on E, Receive B&G on M)
    e. E&M-LINE (Send B&O on M, Receive G&Oon E)
    f. E&M-DROP (Send G&O on E, Receive B&O on M)

8. METER CIRCUIT Switch - Provides the following measuring functions in clockwise sequence:

    a. Speed: 0-25 PPS
    b. % BREAK DIRECT
    c. % BREAK THRU METER RLY

9. EXT DIAL CIRCUIT Switch - Provides the following modes of operation of the external dial circuit in clockwise sequence:

    a. TALK E&M
    b. TALK RT
    c. DIAL RLY-B&G
    d. DIAL RLY-LOOP
    e. DIAL RLY-M
    f. DIAL RLY-E

10. SEND and TEST Key Switch

    a. TEST L&D (operated up)
    b. SEND DIAL (normal)
    c. SEND OSC (operated down)

11. TWD L Key Switch - Provides for connecting the following supervision and measurement functions toward the LINE:

    a. OFF HK and MEAS REC (operated up)
    b. THRU and MEAS (send and receive) (normal)
    c. ON HK and MEAS REC (operated down)

12. TWD D Key Switch - Provides for connecting the follow- supervision and measurement functions toward the DROP:

    a. OFF HK and MEAS REC (operated up)
    b. THRU and MEAS (S&R) (normal)
    c. ON HK and MEAS REC (operated down)

13. SEND Turnbutton Switch - Provides the following send functions on the LOOP jacks:

    a. SEND ON SLEEVES (operated counter clockwise)
    b. SEND ON RT on 1 & 2 (operated clockwise)

14. SPARK SUP Turnbutton Switch - Inserts (ON) or removes (OFF) the internal spark suppressor on the SEND relay contacts.

3.02 The following jacks and terminals (in sequence from left to right) are provided:

a. Jack for EXT (external) dial or telephone set
b. Jack for SEND RELAY contacts
c. Jack for LOOP SIGNALING - LOOP 1
d. Jack for LOOP SIGNALING - LOOP 2
e. Jack for LOOP SIGNALING - SEND B&G
f. Jack for LOOP SIGNALING - REC LOOP
g. Jack for E&M SIGNALING - REC E&M
h. Jack for E&M SIGNALING - E (lead)
i. Jack for E&M SIGNALING - M (lead)
j. Jack for E&M SIGNALING - LINE
k. Jack for E&M SIGNALING - DROP
l. Jack for 48 volts (battery negative on sleeve)
m. Jack for 48 volts (battery negative on tip)
n. EXT adapter connector for accessory covers (located on upper left of panel)
o. Two binding posts, marked EXT DIAL, for an external dial or telephone set (located in upper left hand corner)

3.03 Supervisory Lamps - Two lamps marked LINE (E) and DROP (M) are provided to indicate busy or idle conditions existing on the line and drop circuits.

4.0 CIRCUIT DESCRIPTION

Schematic Diagram

4.01 A block diagram of the set is shown in Fig. 4 and the schematic diagram of the instrument is shown in Fig. 5. The circuits can be divided into two sections - the receive or measuring section, and the pulse send section. A detailed description of each section is presented below.

Receiving and Measuring Section

4.02 The measuring section provides means for measuring the speed or % break of pulses received from loop or E&M circuits. The RECEIVE switch is used to set up the measuring circuit for different modes of operation on loop or E&M circuits. The METER CIRCUIT switch connects the circuit under test to the meter for the measurement of pulse speed or % break. When % break is measured, the

circuit under test may be connected directly to the meter or through a meter slave relay. The meter slave relay should be used for circuits with high capacitance or inductance which might distort the pulse sufficiently to give an erroneous reading when the meter is used directly.

4.03 The measuring circuit includes a 4 1/2" meter with a 1 ma movement. A % BREAK scale calibrated from 0 to 100% in 1% divisions is used to facilitate reading % break. The R-C time constants of the meter circuit have been designed to permit proper reading of the % break when the digit 0 is dialed on an external dial. This damping is also sufficient to keep the angular vibration of the meter pointer to within approximately ±1 division on the meter scale when a pulse rate of 10 pps is measured.

4.04 A PPS scale calibrated from 0 to 25 in 1 pps divisions is used to read pulse speed.

4.05 A calibration control in series with the meter permits setting an accurate full scale reading (i.e., 0% break) for battery voltages from approximately 40 to 55 volts.

4.06 When the meter circuit is required to measure the % break of battery and ground pulses, a compensating network, consisting of resistor R30 and the R29B portion of the meter calibrating potentiometer, is switched into the meter circuit to provide an accurate reading under these conditions. It is to be noted that when receiving battery and ground pulses through the slave relay, this network is not required as the slave relay supplies battery and open pulses to the meter circuit. The variable resistance, R29B, is ganged to the meter calibration control so that it is automatically set to the proper value when the meter is calibrated for full scale, i.e., 0% break. It will be noted that the meter reads approximately 50% break when the set is not connected to a circuit and the RECEIVE switch is in the REC-B&G (M) position, and the FUNCTION switch is in the SEND AND REC position. The same measuring arrangement is provided when the sending and receiving functions are combined in the SEND switch and that switch is in the DROP (M=B&G, E=G&O) position.

4.07 The REC E&M jack makes it possible to receive on either the E or M lead from one circuit without interfering with sending operations on another circuit. When a plug is inserted in the REC E&M jack, the receive circuits are simultantously disconnected from the E, M, LINE, and DROP jacks; these jacks can still be connected to an appropriate sending circuit by the SEND switch.

4.08 When the set is used for measuring incoming signals, the measuring circuits are connected to the appropriate jacks for receiving loop or E&M signals by the RECEIVE switch, which selects the desired mode of operation independent of the sending

functions. The connections which can be established for each position of the RECEIVE switch are as follows in clockwise sequence:

a. REC B&G ON LOOP: the receive meter circuit is directly connected to the REC LOOP jack.

b. REC LOOP: battery is furnished through the meter to the tip and ground is extended to the ring of the REC LOOP jack requiring only an open and closure of a dry loop for a measurement.

c. REC B&O (M): the meter circuit is connected to the ring of the REC E&M jack and the ring (M) of the DROP jack.

d. REC B&G (M): the meter circuit is connected to the ring of the REC E&M jack and the ring (M) of the DROP jack.

e. REC G&O (E): the meter circuit is connected to the tip of the REC E&M jack, to the E jack, and to the tip (E) of the LINE jack.

4.09 It is possible to combine the receiving and sending operations in fixed combinations by setting the RECEIVE switch to the extreme clockwise position. This transfers control of the receiving mode of operation to the SEND switch. The SEND switch will then establish the receive connections as follows in clockwise sequence:

a. SEND LOOP, REC B&G: the receive meter circuit is directly connected to the REC LOOP jack.

b. SEND LOOP, REC LOOP: battery is furnished through the meter to the tip, and ground is extended to the ring of the REC LOOP jack, requiring only an open and closure of a dry loop for a measurement.

c. LINE (M=B&G, E=G&O): the meter circuit is connected to the E jack and the tip (E) of the LINE jack.

d. DROP (M=B&G, E=G&O): the meter circuit is connected to the ring (M) of the DROP jack.

e. LINE (M=B&O, E=G&O): the meter circuit is connected to the E jack and tip (E) of the LINE jack.

f. DROP (M-B&O, E-G&O): The meter circuit is connected to the ring (M) of the DROP jack.

4.10 No connections are established between the measuring circuit and the REC E&M jack when the sending and receiving functions are combined in the SEND switch.

4.11 A description of the sending functions is covered in the section devoted to the sending part of the set. A diagram showing the circuit connections which are established for the combined sending and receiving operations is shown in Fig. 2.

4.12 The receiving circuits are connected to the measuring circuit through the METER CIRCUIT switch as follows:

a. In the PPS position a relay is inserted in the external circuit; its contacts operate a frequency measuring circuit. In this condition the meter reads pulses per second (PPS).

b. In the center position, marked % BREAK DIRECT, the meter is operated as a % break meter and connected directly to the circuit under test.

c. In the % BREAK THRU RLY position the winding of a slave relay is connected to the receiving circuits and the meter reads the % break on the contacts of this slave relay.

Sending Section

4.13 The sending section of the set provides the means for generating signals which may be sent on loop or E&M circuits. When the FUNCTION switch is in the SEND AND REC position, the TEST-SEND key switch selects the following sources of signal:

a. in its normal position a continuous pulse train controlled by an internal oscillator. The frequency of this oscillator can be controlled by the PULSES PER SEC switch.

b. in its operated down position dial pulses or other signals generated in circuits connected to the EXT dial jack.

In either case the % break of the send signals can be controlled by the ADJ % BREAK control, and can be measured on the % BREAK scale of the meter incorporated in the set. To check the % break of the transmitted signal, the FUNCTION switch is temporarily moved to the ADJ % BREAK position.

4.14 When the internal oscillator is used, a sine wave signal is supplied to one winding of the DRIVE relay. When an external

dial circuit is used, signals having a wave shape approximating the sine wave are supplied to this same winding. The other winding of this relay is connected to a DC circuit in which positive or negative bias can be applied under the control of the ADJ % BREAK potentiometer. The DC bias shifts the operating point of the DRIVE relay and causes it to transmit pulses which are lengthened or shortened as compared to those transmitted in the absence of any bias.

4.15 In the biasing circuit described above, the effective drive power of the relay becomes unsymmetrical and appreciable amounts of armature transfer time can occur. Thus it is not desirable to derive the sending signals directly from the DRIVE relay. For this reason the contacts of the DRIVE relay are used to drive a second relay, the SEND relay. This second relay obtains full excitation whenever the DRIVE relay operates. As a result of the bi-stable characteristics of the SEND relay, assisted by the spark suppressors on the DRIVE relay contacts, the transfer time of the SEND relay is kept low under all conditions. In order to permit use of the TTS 26B for switching of voice frequency circuits, the spark suppressors can be omitted from the contacts of the SEND relay by operating the SPARK SUP turnbutton switch to OFF. If the TTS 26B is to be used on high power or highly inductive circuits, the internal spark suppressor circuit should be used. Access to the armature, make, and break contacts of the SEND relay is obtained on the tip, ring, and sleeve of the SEND RELAY jack.

CAUTION: If the TTS 26B SEND circuits will be switching currents of more than 100 ma, voltages in excess of 50 volts, or inductive circuits, the internal SPARK SUP turnbutton should be operated to ON. This internal suppressor circuit, when connected, protects the SEND relay contacts with arc reduction networks of 0.1 mfd and 220 ohms. These values are generally satisfactory for standard 48 relay switching circuits. Care must be used when spark suppression is added that the performance of the circuits under test is not affected by the spark suppression circuit.

4.16 The internal oscillator is a conventional, transistorized, sine wave oscillator equipped with a buffer amplifier to provide the desired signal level to operate the DRIVE relay. When the external dial is used to control the SEND relay, the operation of the dial causes the DIAL relay to operate. The armature of this relay applies battery or ground to a low pass filter. The output of the low pass filter has the sloping waveform which is necessary to obtain proper bias control in the DRIVE relay. To obtain a maximum range of control, the filter condenser in the low pass filter should be switched to correspond to the dial speed. This is automatically done by turning the PULSES PER SEC control to the position corresponding to the speed of the dial used.

4.17 When pulsing signals are generated by the internal oscillator, these signals are applied to the DRIVE relay directly by the SEND AND TEST key switch. When these signals are generated externally, it is also necessary to use the EXT DIAL CIRCUIT switch and set it in the position applicable to the external circuit conditions; Fig. 3 shows the circuit connections which may be established under control of this switch. A further explanation of the use of the EXT DIAL CIRCUIT switch is presented in Paragraph 4.21.

4.18 Loop or E&M signals are connected to the appropriate SEND jacks by the SEND switch in the following manner in clockwise sequence:

a. SND LOOP
REC B&G: a pulsing open or short condition is applied to the tip and ring of the LOOP SIGNALING-SEND 1 and 2 jacks for circuits which provide battery and ground.

b. SEND LOOP
REC LOOP: When the SEND turnbutton switch is in the RT ON 1 & 2 position, a pulsing open or short condition is applied to the tip and ring of the LOOP SIGNALING-SEND 1 and 2 jacks for circuits which provide battery and ground. When the SEND turnbutton switch is in the SLEEVES position, the armature of the SEND relay is connected to the sleeve of the LOOP SIGNALING-SEND LOOP 2; the on hook contact of the SEND relay to the sleeve of LOOP SIGNALING SEND LOOP 1; and the off hook contact to the sleeve of the REC LOOP jack. In this condition no connections are made to the T and R leads of SEND LOOP jacks 1 and 2.

c. LINE (M=B&G, E=G&O): signaling with battery and ground applied to the M lead on the ring of the LINE jack and on the M jack. The battery is supplied through a resistance lamp.

d. DROP (M=B&G, E=G&O): Signaling with ground and open applied to the E lead on the tip of the DROP jack.

e. LINE (M=B&O, E=G&O): Signaling with battery and open applied to the M lead on the ring of the LINE jack and on the M jack. The battery is supplied through a resistance lamp.

f. DROP (M=B&O, E=G&O): Signaling with ground and open applied to the E lead on the tip of the DROP jack.

The receive functions of the combined SEND and RECEIVE operations are covered in Paragraph 4.09.

4.19 An additional loop signaling arrangement is provided in which battery and ground are applied to an external "dry" circuit under control of the SEND relay. This arrangement is available on the SEND B&G jack under LOOP SIGNALING when the SEND switch is in the LINE (M=B&O E=G&O) position. Battery and open appear on the ring and ground appears on the tip of the jack.

4.20 For special applications it may be desirable to have available means for pulsing the sleeves of the LOOP jacks. By turning the SEND turnbutton switch to SLEEVES two different arrangements are obtained when the SEND switch is in the SND LOOP REC LOOP position as follows:

a. A pulsing open and short condition is applied between the sleeves of the SEND 1 and 2 jacks.

b. A pulsing open and short condition is applied between the sleeve of the SEND 2 jack and the sleeve of the REC LOOP jack.

Pulse Repeater and Pulse Converter Functions

4.21 External keying circuits may be connected through the EXT DIAL jack, or binding posts, which in turn cause the DIAL relay to follow the pulses as received. Signals may derive from external loop or E&M circuits, or from an external dial.

4.22 The following functions are provided for each of the DIAL RLY positions of the EXT DIAL CIRCUIT switch. A simplified schematic of these circuits is shown in Fig. 3.

a. DIAL RLY B&G: Ground is applied to the tip of the EXT DIAL jack through the relay, and battery is applied to the ring. This permits "dry" contact pulsing to be received from the external circuit.

b. DIAL RLY LOOP: The winding of the relay is connected directly to the EXT DIAL jack. This permits "wet" contact pulsing to be received from the external circuit.

c. DIAL RLY M: One side of the relay winding is connected to ground, and the other side is connected to the ring of the EXT DIAL jack to receive signals from an M lead.

d. DIAL RLY E: One side of the relay winding is connected to battery through a 1000-ohm resistor, and the other side is connected to the tip of the EXT DIAL jack to receive signals from an E lead.

4.23 When the FUNCTION switch is in the SEND AND REC position and the SEND AND TEST key switch is in the DIAL position, the signal received on the EXT DIAL jack is retransmitted through whichever SEND jacks are selected by the SEND switch. By turning the FUNCTION switch temporarily to the ADJ % BREAK position, the % break of the signals transmitted by the send circuit may be controlled and measured. Thus, it is possible to use the set as a repeater with an adjustable % break, or to convert loop signals to E&M signals or vice versa, and also control the % break of the converted signal.

4.24 SEND RELAY Jack - When a cord is inserted in the jack marked SEND RELAY, the tip, ring, and sleeve of this cord give immediate access to the contacts of the SEND relay and thereby permit pulsing external circuits such as oscillators, etc., at an adjustable % break. All other circuits in the set are disconnected from the relay contacts when the SEND RELAY jack is used. The position of the SPARK SUP switch determines whether or not the spark suppression circuit is across the relay terminals.

4.25 Line and Drop Busy Test - When the TTS 26B is to be used on E&M circuits, it is desirable to determine first if the circuit is idle or not busy before applying any test signals to it. When the SEND-TEST key is in the TEST L&D position, and the TWD-L and TWD-D key switches are in the THRU & MEAS position, the E&M leads of the LINE and DROP jacks are connected through, and the LINE and DROP lamps are connected to the E and M leads respectively on the LINE, DROP jacks and also on the E and M. jacks. When the lamps are lit, an on hook condition on the circuit under test is indicated. When the lamps are extinguished, an off hook condition is indicated. Normally, prior to connection of the TTS 26B to the circuit under test, both lamps are lighted as an indication of lamp circuit continuity.

4.26 Supervisory Signals - On hook and off hook signals may be applied independently toward the line and drop by means of the TWD-L and TWD-D key switches. When either of these keys is operated to either the ON HK or OFF HK position, the associated internal signaling circuits are removed from the line and drop and the desired supervisory signals are applied as follows:

a. TWD-L in OFF HK position, applies battery to the M jack and the M lead or ring of the LINE jack.

b. TWD-L in ON HK position, applies a ground to the M jack and the M lead or ring of the LINE jack.

c. TWD-D in OFF HK position, applies a ground to the E lead or tip of the DROP jack.

d. TWD-D in ON HK position applies an open to the E lead or tip of the DROP jack.

Dialing and Talking Functions

4.27 A lineman's telephone set or a subscriber's set may be connected to the EXT DIAL jack or binding posts to dial out or talk on a loop or E&M supervised circuit. The dialing functions have already been reviewed in Paragraphs 4.17, 4.21, and 4.22.

4.28 When the EXT DIAL CIRCUIT switch is set at TALK EM or TALK RT, the EXT DIAL jack and binding posts are connected to the tip and ring of the SEND 1 and 2 jacks as follows:

a. TALK EM: the sending circuit is connected to the EXT DIAL jack through 2 mfd blocking capacitors, and battery is applied through 500 ohms to the ring of the jack, and the tip is connected to ground through 500 ohms. This provides battery for talking on a dry circuit.

b. TALK RT: the sending circuit is connected directly to the EXT DIAL jack to permit talking on a loop or wet circuit.

5.0 OPERATING PROCEDURES

General

5.01 The different circuits which can be set up under the control of the RECEIVE and SEND switches are shown, in condensed form, in Figs. 1 and 2. They illustrate in simplified form the circuits connected to the various jacks for different positions of the RECEIVE and SEND switches when the FUNCTION switch is in the SEND AND REC position. These diagrams serve as a quick reference to determine what test circuit connections are being used.

Initial Steps

5.02 The following steps should be taken to prepare the set for operation:

a. Unlatch and open cover. The cover can easily be detached by sliding it to the right side of the instrument. If cords or other items stored in the cover are needed, the hinged lid may be opened by first turning the thumbscrew which serves as a latch.

b. Check the position of the meter pointer; it should be on the 100 line of the % BREAK scale. If it is off, adjust the screw on the meter panel to properly position the pointer. After the adjustment has been made, back off the adjustment screw slightly to remove mechanical contact between adjustment screw and meter mechanism.

c. Connect a cord to the proper 48-volt jack in the TTS 26B first, then connect the other end of the cord to a 48-volt supply jack. When disconnecting the set, remove the cord from the supply jack first. In the event that battery is reversed, the TTS 26B will not be damaged because an internal protective internal diode is provided; however, it would not be possible to calibrate or use the instrument in this condition.

d. Set the PULSES PER SEC switch to the desired pulse rate if the oscillator is to be used as a source of signal. This turns the set on. If a dial or other external circuit is to be used as a source of signal, this switch should be set to correspond to the speed of the circuit which is connected to the DIAL jack.

e. With reference to the simplified functional circuit diagram of Figs. 1 and 2, turn the RECEIVE AND SEND switches to the desired operating mode.

f. Calibration is covered under the type of operation desired.

NOTE: Calibration should be rechecked when the position of the RECEIVE or SEND switch is changed.

g. The instrument is now ready for use.

CAUTION: If the TTS 26B sending circuits will be switching currents of more than 100 ma, voltages in excess of 50 volts, or inductive circuits, the SPARK SUP turnbutton should be operated to ON to connect the internal spark suppressor circuit. This internal suppressor circuit, when connected, protects the SEND relay contacts with arc reduction networks of 0.1 mfd and 220 ohms. These values are generally satisfactory for standard 48-relay switching circuits.

Calibrating for % Break Measurements

5.03 The meter circuit of the TTS 26B must be calibrated for the supply voltage used. The instrument will operate satisfac-

torily and the METER CAL control will calibrate the meter over a range of input voltage extending from approximately 40 volts to 55 volts.

5.04 The following procedure is used for calibrating the meter circuit:

a. Complete the initial steps as covered in Paragraph 5.02.

b. Set the SEND AND TEST key to SEND OSC. If a dial is used as a source of pulses, set this key to SEND DIAL.

c. Note that the PULSES PER SECOND switch is set at the desired speed. This also turns the set ON. This should be done whether the internal oscillator or an external source of pulses is to be used.

d. Turn the FUNCTION switch to the CAL METER position.

e. Adjust the METER CAL control to set the meter point at 0 on the % BREAK meter scale.

f. Turn the FUNCTION switch to the ADJ % BREAK position.

g. Set the ADJ % BREAK control for the desired % break as indicated on the meter. When a DIAL is used to generate the signal, dial a series of zeros when setting the the desired % BREAK.

h. Turn the FUNCTION switch to the SEND AND REC position.

i. The set now is ready to send pulses at the predetermined rate and % break.

j. For receiving measurements an additional step is necessary. With the distant end of the receive circuit in the off hook condition, observe the % BREAK meter; if it does not indicate 0%, adjust the METER CAL control to bring the needle to the 0 mark. This calibration should be rechecked whenever the position of the SEND switch, RECEIVE switch, or external receive circuit is changed.

k. The instrument is now ready for use.

CAUTION: If, after completing Steps a through i, it is desired to recheck the % break, then all steps, starting with Step e, must be repeated.

Measuring % Break of a Received Signal

5.05 Before conducting any receiving measurements, it is important to adjust the METER CAL control first as outlined in Paragraph 5.04-j. If this procedure is not followed, the voltage drop in the circuit under test is not taken into consideration and an erroneous reading of the % break may be obtained. This operation must be performed after the RECEIVE switch has been set in the desired position as described below.

5.06 All % break measurements are made with the following switches set as indicated.

a. FUNCTION switch in SEND AND REC position.

b. METER CIRCUIT switch in % BREAK DIRECT position.

If measurements are made on circuits which have high inductance or capacitance which may distort the pulse wave shape, the METER CIRCUIT switch should be set in the % BREAK THRU METER RLY position or erroneous readings may be obtained.

5.07 To measure % break on wet loop circuits:

a. Set RECEIVE switch to REC B&G ON LOOP position.

b. Connect circuit to REC LOOP jack. The battery side must be connected to the tip and ground to the ring.

c. Read % break on % BREAK scale of meter.

5.08 To measure % break on dry loop circuits:

a. Set RECEIVE switch to REC LOOP position.

b. Connect circuit to REC LOOP jack.

c. Read % break on % BREAK scale of meter.

5.09 To measure % break of battery and open pulses on an M lead:

a. Set the RECEIVE switch to the REC B&O (M) position.

b. Connect the M lead of the circuit to the ring of the DROP jack or to the ring of the REC E&M jack.

c. Read % break on the % BREAK scale of the meter.

5.10 To measure % break of battery and ground pulses on an M lead:

a. Set the RECEIVE switch to the REC B&G (M) position.

b. Connect the M lead of the circuit to the ring of the DROP jack or to the ring of the REC E&M jack.

c. Read % break on the % BREAK scale of the meter.

5.11 To measure % break of ground and open pulses on an E lead:

a. Set the RECEIVE switch to the REC G&O (E) position.

b. Connect the E lead of the circuit to the E jack, the tip of the LINE jack, or the tip of the REC E&M jack.

c. Read % break on the % BREAK scale of the meter.

5.12 The RECEIVE operations can be combined with the specific SEND operations by turning the RECEIVE switch to the extreme clockwise position. Instructions for using these combinations are included in a later paragraph.

Sending Signals with a Predetermined % Break

5.13 When signals are to be sent on loop or E&M circuits, the SEND switch controls the mode of operation. The % BREAK of the signal to be sent is established for each position of the SEND switch as follows:

a. Set the SEND switch to the desired mode of operation.

b. Set the METER CIRCUIT switch in the % BREAK DIRECT position.

c. Perform the initial steps as covered in Paragraph 5.02 and calibrate the meter circuit in accordance with the instructions of Paragraph 5.03.

d. Set the FUNCTION switch in the CAL-ADJ % break position.

e. Move the SEND AND TEST key switch to the SEND OSC position.

f. Turn the ADJ % BREAK knob until the meter reads the % break which is to be sent.

NOTE: Since the ADJ % BREAK control may be positioned in the extreme clockwise or counter-clockwise position when the set is first turned on, the meter may not give any indication that the internal oscillator is operating. In this case, turn the knob until a meter reading is obtained.

g. If a dial is used to generate the signals, place the TEST AND SEND key switch in the SEND DIAL position and dial the digit 0. Note the meter reading. Repeat the operation and turn the ADJ % BREAK knob until the desired % break is obtained.

h. After the desired % break has been established, turn the FUNCTION switch to SEND AND REC. The set may now be used to send signals.

CAUTION: When the TTS 26B is used to pulse such circuits as pulse repeaters, carrier pulsing units, etc., care

should be exercised to simulate the pulsing source in the system under test.

In many cases the pulsing source will have a spark suppression circuit across the pulsing contacts. If the spark suppression is not used in the pulsing test set, erroneous results will be obtained. The TTS 26B has spark suppression available for the pulsing relay in the set. To add the spark suppression, turn the turnbutton switch marked SPARK SUP to ON; this will simulate the spark suppression of the pulsing circuit in the system under test. Unless the spark suppression is required, it is recommended that the SPARK SUP switch be left in the OFF position.

5.14 To send dry contact loop signals on a loop circuit:

a. Connect the circuit to either the SEND 1 or SEND 2 jack under LOOP SIGNALING on the panel.

b. Turn the SEND switch to either of the two SEND LOOP positions. However, if the SEND LOOP, REC LOOP position is used, the SEND turnbutton switch in the lower left hand corner of the set must be turned to the RT ON 1 and 2 position. In other positions of the SEND switch, the SEND turnbutton switch has no effect.

c. Adjust the % break of the sending signal as described in Paragraph 5.13.

d. Turn the FUNCTION switch to SEND AND REC.

5.15 To send battery and ground on a dry loop circuit:

a. Connect the circuit to the SEND B&G jack under LOOP SIGNALING on the panel.

b. Turn the SEND switch to the LINE (M=B&O, E=G&O) position.

c. Adjust the % break of the SEND signal as described in Paragraph 5.13.

d. Turn the FUNCTION switch to SEND AND REC.

5.16 To send battery and ground on the M lead of an E&M circuit:

a. Connect the M lead of the circuit to the ring of the LINE jack, or to the M jack.

b. Turn the SEND switch to the LINE (M=B&G, E=B&O) position.

c. Adjust the % break of the SEND signal as described in Paragraph 5.13.

d. Turn the FUNCTION switch to SEND AND REC.

5.17 To send ground and open on the E lead of an E&M circuit:

a. Connect the E lead of the circuit to the tip of the DROP jack.

b. Turn the SEND switch to the DROP (M=B&G, E=G&O) position.

c. Adjust the % break of the sending signal as described in Paragraph 5.13.

d. Turn the FUNCTION switch to SEND AND REC.

5.18 To send battery and open on the M lead of an E&M circuit:

a. Connect the M lead of the circuit to the ring of the LINE jack, or to the M jack.

b. Turn the SEND switch to the LINE (M=B&O, E=G&O) position.

c. Adjust the % break of the sending signal as described in Paragraph 5.13.

d. Turn the FUNCTION switch to SEND AND REC.

5.19 To send ground and open on the E lead of an E&M circuit:

a. Connect the E lead of the circuit to the tip of the DROP jack.

b. Turn the SEND switch to the DROP (M=B&O, E=G&O) position.

c. Adjust the % break of the sending signal as described in Paragraph 5.13.

d. Turn the FUNCTION switch to SEND AND REC.

Fixed Combinations of Sending and Receiving

5.20 Fixed combinations of the sending and receiving operations are established by turning the RECEIVE switch to the extreme clockwise position; the marking of this position points to the SEND AND REC designations under the SEND switch. Fig. 2 illustrates the combinations of SEND and RECEIVE that are established for each position of the SEND switch.

5.21 All receiving operations are to be made after the instructions in Paragraphs 5.05, 5.06, and 5.07 have been followed.

5.22 All sending operations should be made after the instructions in Paragraph 5.13 have been followed.

5.23 To send dry contact loop pulses and receive wet contact loop pulses:

a. Connect the incoming loop circuit to the REC LOOP jack. The battery side must be connected to the tip and ground to the ring.

b. Connect the outgoing loop circuit to the SEND 1 or 2 jack.

c. Turn the SEND switch to SND LOOP, REC B&G

d. Turn the FUNCTION switch to SEND AND REC.

e. Read % break of received signal on the % BREAK scale of the meter.

5.24 To send dry contact loop pulses and receive dry contact loop pulses:

a. Connect the incoming loop circuit to the REC LOOP jack.

b. Connect the outgoing loop circuit to the SEND 1 or 2 jack. The SEND turnbutton switch must be turned to RT ON 1 & 2.

c. Turn the SEND switch to SND LOOP, REC LOOP.

d. Turn the FUNCTION switch to SEND AND REC.

e. Read % break of received signal on the % BREAK scale of the meter.

5.25 To send B&G on the M lead and receive G&O on the E lead of an E&M circuit:

a. Connect the E lead to the E jack or to the tip (E) of the LINE jack.

b. Connect the M lead to the M jack or to the ring (M) of the LINE jack.

c. Turn the SEND switch to LINE (M=B&G, E=G&O).

d. Turn the FUNCTION switch to SEND AND REC.

e. Read % break of the signal on the E lead on the % BREAK scale of the meter.

5.26 To send G&O on the E lead and receive B&G on the M lead of an E&M circuit:

a. Connect the M lead to the ring (M) of the DROP jack.

b. Connect the E lead to the tip (E) of the DROP jack.

c. Turn the SEND switch to DROP (M=B&G, E=G&O).

d. Turn the FUNCTION switch to SEND AND REC.

e. Read % break of the signal on the M lead on the % BREAK scale of the meter.

5.27 To send B&O on the M lead and receive G&O on the E lead of an E&M circuit:

a. Connect the E lead to the E jack or the tip (E) of the LINE jack.

b. Connect the M lead to the M jack or the ring (M) of the LINE jack.

c. Turn the SEND switch to LINE (M=B&O, E=G&O).

d. Turn the FUNCTION switch to SEND AND REC.

e. Read % break of the signal on the E lead on the % BREAK scale of the meter.

5.28 To send G&O on the E lead and receive B&O on the M lead of an E&M circuit:

a. Connect the M lead to the ring (M) of the DROP jack.

b. Connect the E lead to the tip (E) of the DROP jack.

c. Turn the SEND switch to DROP (M=B&O, E=G&O).

d. Turn the FUNCTION switch to SEND AND REC.

e. Read % break of the signal on the M lead on the % BREAK scale of the meter.

Measuring the Speed of a Signal

5.29 To measure the speed of received signals, the METER CIRCUIT switch must be set at 0-25 PPS and a meter calibration

performed as outlined under Paragraph 5.30. The instructions under a and b of Paragraphs 5.07 to 5.11 inclusive are to be followed in establishing the connections for the type of circuit to be tested. Read the speed of the signal on the PPS scale of the meter.

5.30 If it is desired to check the speed of the pulses generated by the oscillator in the TTS 26B, the following procedure may be used:

a. Connect the 48-volt DC voltage source to the proper jack as indicated on the front panel and set the METER CIRCUIT switch at 0-25 PPS.

b. Set the FUNCTION switch at CAL METER and adjust the METER CAL control to get the meter pointer at 0 on the % BREAK meter scale.

c. Patch the SEND LOOP 1 or 2 jack into the REC LOOP jack.

d. Set the FUNCTION switch at SEND AND REC.

e. Set the PULSES PER SEC switch to the desired speed.

f. Set the SEND AND TEST key switch to SEND OSC.

g. Set the RECEIVE switch to REC LOOP.

h. Set the SEND switch to either SND LOOP or REC B&G.

i. Read the signal speed on the PPS scale of the meter.

5.31 If the speed of a dial is to be checked, use the following procedure:

a. Calibrate as outlined in Paragraph 5.30, a and b.

b. Connect the dial to the REC LOOP jack.

c. Set the FUNCTION switch at SEND AND REC.

d. Set the METER CIRCUIT switch at 0-25 PPS.

e. Set the RECEIVE switch to REC LOOP.

f. Dial the digit 0 on the dial.

g. Read the dial pulse speed on the PPS scale of the meter.

Special Functions

5.32 To pulse an open and short on the sleeves of the loop jacks:

a. The calibration operations and setting of the desired % break of the pulsing signal should be made in accordance with instructions in Paragraphs 5.04 and 5.13.

b. Turn the SEND switch to SND LOOP, REC LOOP.

c. Turn the SEND turnbutton switch to SLEEVES.

d. Turn the FUNCTION switch to SEND AND REC.

e. Pulsing on the sleeves is now available on the following LOOP jacks:

(1) SEND 2 and REC LOOP: Relay contacts normally closed.

(2) SEND 1 and SEND 2: Relay contacts normally open.

(3) Armature of pulsing relay on SEND 2:

Normally open contact of relay on SEND 1.
Normally closed contact of relay on REC LOOP.

5.33 To use as pulse repeater or converter:

a. Connect a dial or a circuit with incoming signals to the EXT DIAL jack or binding posts.

b. Turn EXT DIAL CIRCUIT switch to one of the applicable positions listed below:

(1) DIAL RLY B&G: Used when dry contact pulsing is received on a loop or is generated by a dial.

(2) DIAL RLY LOOP: Used when wet contact pulsing is received on a loop.

(3) DIAL RLY M: Used to receive battery and open or battery and ground pulses on an M lead.

(4) DIAL RLY E: Used to receive ground and open pulses on an E lead.

c. Turn the SEND switch to the desired mode of operation.

d. Set the SEND AND TEST key switch in the SEND DIAL position.

e. Adjust the % break of the signal to be transmitted in accordance with the procedure in Paragraph 5.13.

f. Turn the FUNCTION switch to SEND AND REC.

g. Connect the circuit on which the repeated pulses are to be sent to the appropriate LOOP SIGNALING or E&M SIGNALING jack.

5.34 To monitor in-service pulsing on LINE and DROP:

a. Turn SEND switch to SND LOOP, REC LOOP.

b. Turn REC switch to appropriate receive position for receiving on either the M or E lead.

c. Turn the FUNCTION switch to SEND AND REC.

d. Place the TEST-SEND key switch in the TEST position.

e. Connect the line and drop to the LINE and DROP jacks.

f. The L and D lamps will indicate if the circuit is busy.

g. To measure the signals on the line or drop, place the TEST-SEND switch in the SEND position.

h. Measure the % break of signals on the meter.

5.35 Dialing and talking through set:

a. A lineman's telephone set or a subscriber's set may be connected to the EXT DIAL jack or binding posts to dial out or talk on a loop or E&M supervised circuit.

b. To dial:

(1) Connect a dial or a telephone set with a dial to the EXT DIAL jack or binding posts.

(2) Turn the EXT DIAL CIRCUIT switch to the DIAL RLY B&G position.

(3) Turn the SEND switch to the desired position.

(4) Set the TEST-SEND switch in the SEND DIAL position.

(5) Adjust the % break in accordance with the procedure in Paragraph 5.13.

(6) Turn the FUNCTION switch to SEND AND REC.

(7) Connect the circuit on which the dial pulses are to be transmitted to the appropriate SEND jack.

c. To talk:

(1) LOOP: After a number is dialed on a LOOP circuit, it is possible to listen to the ringing and talk on the circuit by turning the EXT DIAL CIRCUIT switch to the TALK RT position.

(2) E&M: After a number is dialed on an E&M circuit, it is possible to talk on a dry talk circuit which may be available by turning the EXT DIAL CIRCUIT switch to the TALK EM position and connecting the tip and ring of the E&M circuit to either of the SEND LOOP jacks.

5.36 To use send relay contacts directly - When a cord is inserted in the jack marked SEND RELAY, the tip, ring, and sleeve of this cord give immediate access to the contacts of the SEND relay and thereby permit pulsing external circuits such as oscillators, etc., at an adjustable % break. All other circuits in the set are disconnected from the relay contacts when the SEND RELAY jack is used. The position of the SPARK SUP turnbutton switch determines whether or not the spark suppression circuit is across the relay terminals. The SEND RELAY jack is connected to the SEND RELAY contacts as follows:

a. Ring: normally closed contact.

b. Tip: armature.

c. Sleeve: normally open contact.

5.37 Application of supervisory signals to E&M circuits:

a. Plug the E&M circuits into the LINE and DROP jacks.

b. Operate the TWD-L key switch to apply an OFF HK or an ON HK toward the LINE.

c. Operate the TWD-D key switch to apply an OFF HK or an ON HK toward the DROP.

d. Receiving measurements may still be made.

5.38 To send an on hook or off hook to leep and E&M circuits:

a. Plug the circuit into the appropriate LOOP or E&M jack.

b. Turn the SEND switch to the appropriate position for the external circuit used.

c. Turn the FUNCTION switch to SND OFF HK or SND ON HK as desired.

5.39 Line and drop busy test:

a. Move the SEND AND TEST key switch to the TEST L&D position and move both the TWD-L and TWD-D key switches to their THUR+MEAS (normal) positions.

b. Plug the E&M circuits into the LINE and DROP jacks.

c. If the lamps designated LINE (E) and DROP (M) remain lighted, the circuit is not busy. If either of the lights goes out, the circuit is busy.

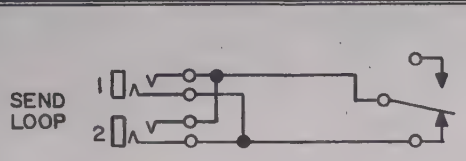
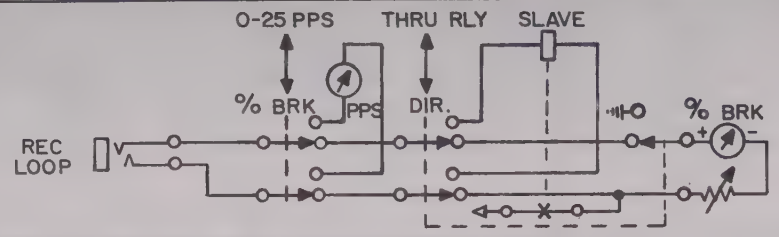
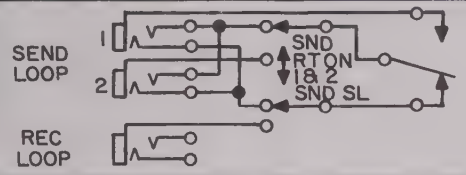
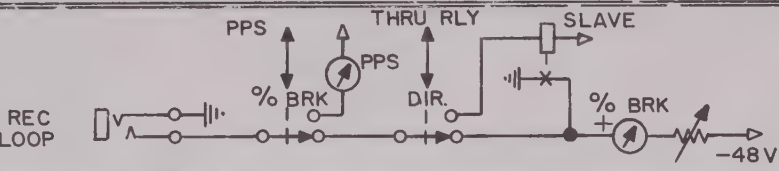
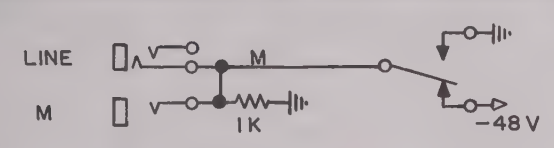
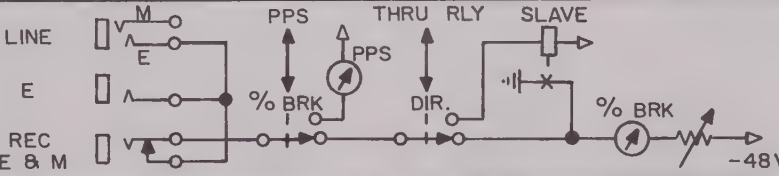
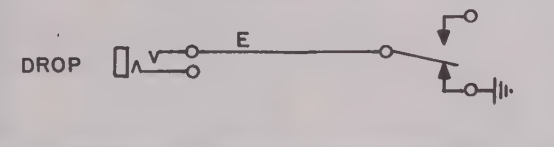
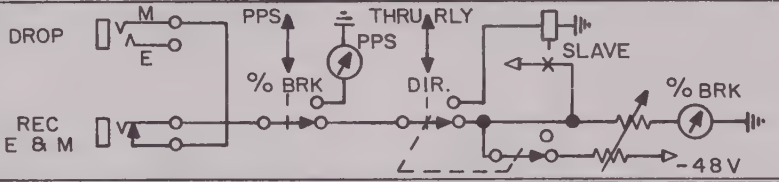
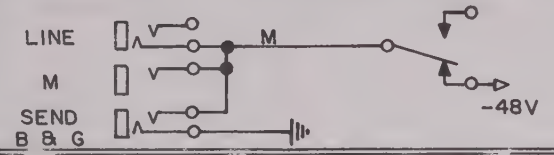
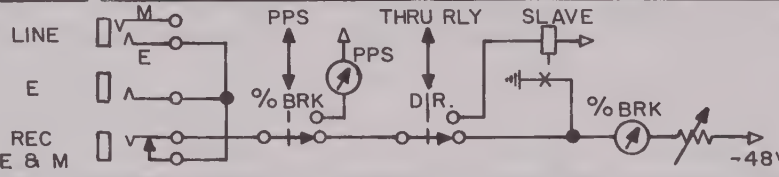
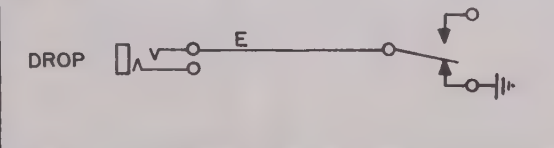
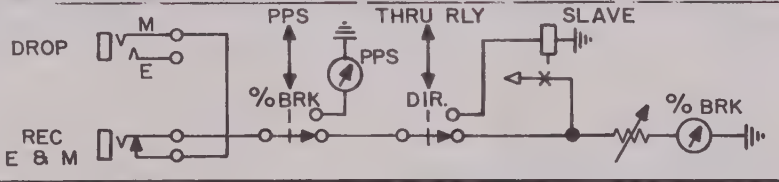
SEND AND RECEIVE CIRCUITS

SEND CIRCUITS (FIG. 1)

SELECTED BY SEND SWITCH AND INDEPENDENT OF RECEIVE SWITCH POSITION

RECEIVE CIRCUITS (FIG. 2)

SELECTED BY SEND SWITCH WHEN RECEIVE SWITCH IS IN COMBINED POSITION.
SELECTED BY RECEIVE SWITCH FOR ALL OTHER POSITIONS OF RECEIVE SWITCH.

SEND & REC. SWITCH	SEND CIRCUIT	RECEIVE CIRCUIT	
SND - LOOP REC.- B & G SEND & REC. SW.			REC-B & G ON LOOP RECEIVE SW.
SND - LOOP REC - LOOP SEND & REC. SW.			REC. LOOP RECEIVE SW.
LINE E & M E = G & O M = B & G SEND & REC. SW.			REC-G & O ON LINE (E) AND ON E RECEIVE SW.
DROP E & M E = G & O M = B & G SEND & REC. SW.			REC-B & G ON DROP (M) RECEIVE SW.
LINE E & M E = G & O M = B & O SEND & REC. SW.			REC-G & O ON LINE (E) AND ON E RECEIVE SW.
DROP E & M E = G & O M = B & O SEND & REC. SW.			REC-B & O ON DROP (M) RECEIVE SW.

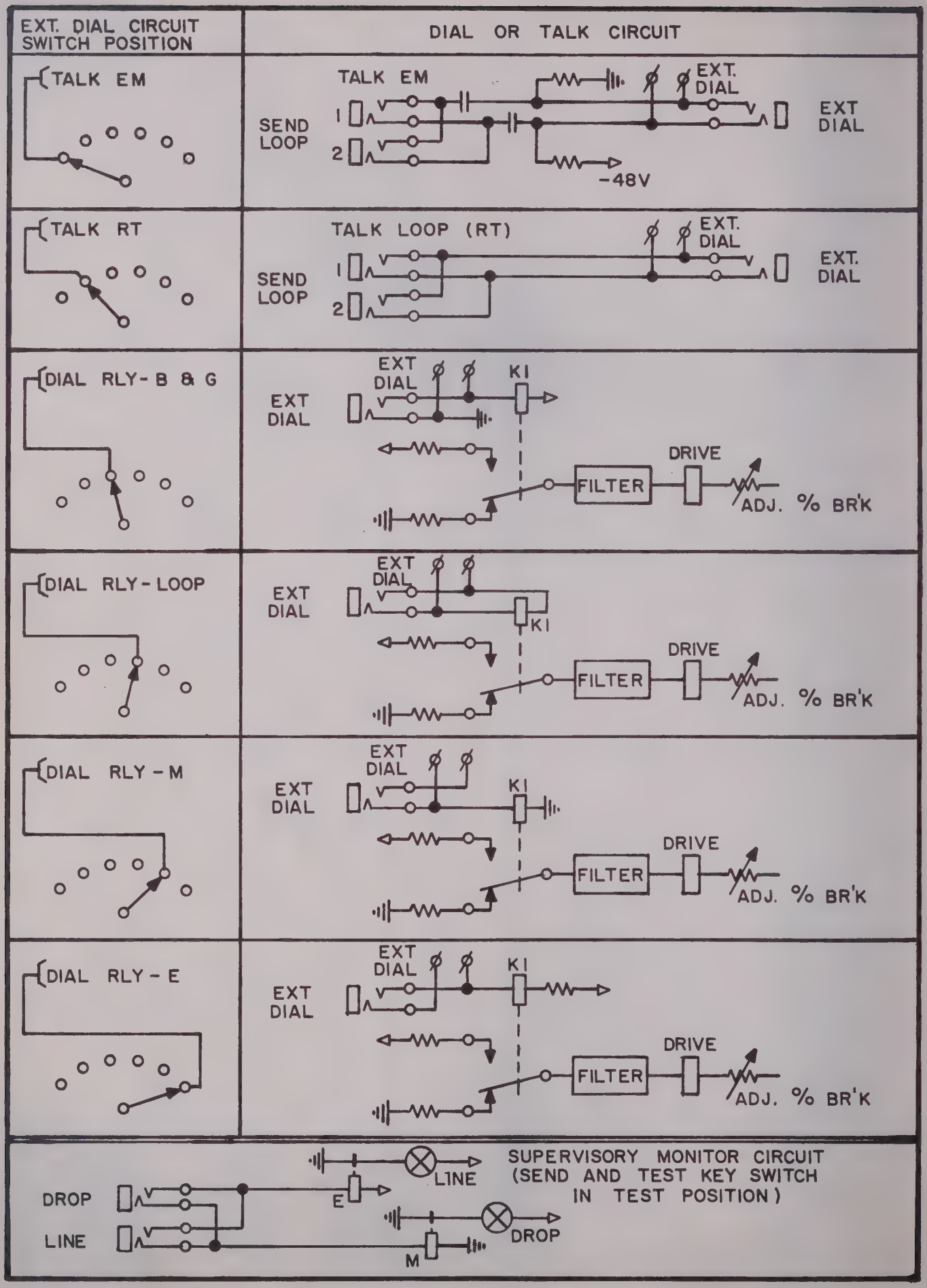
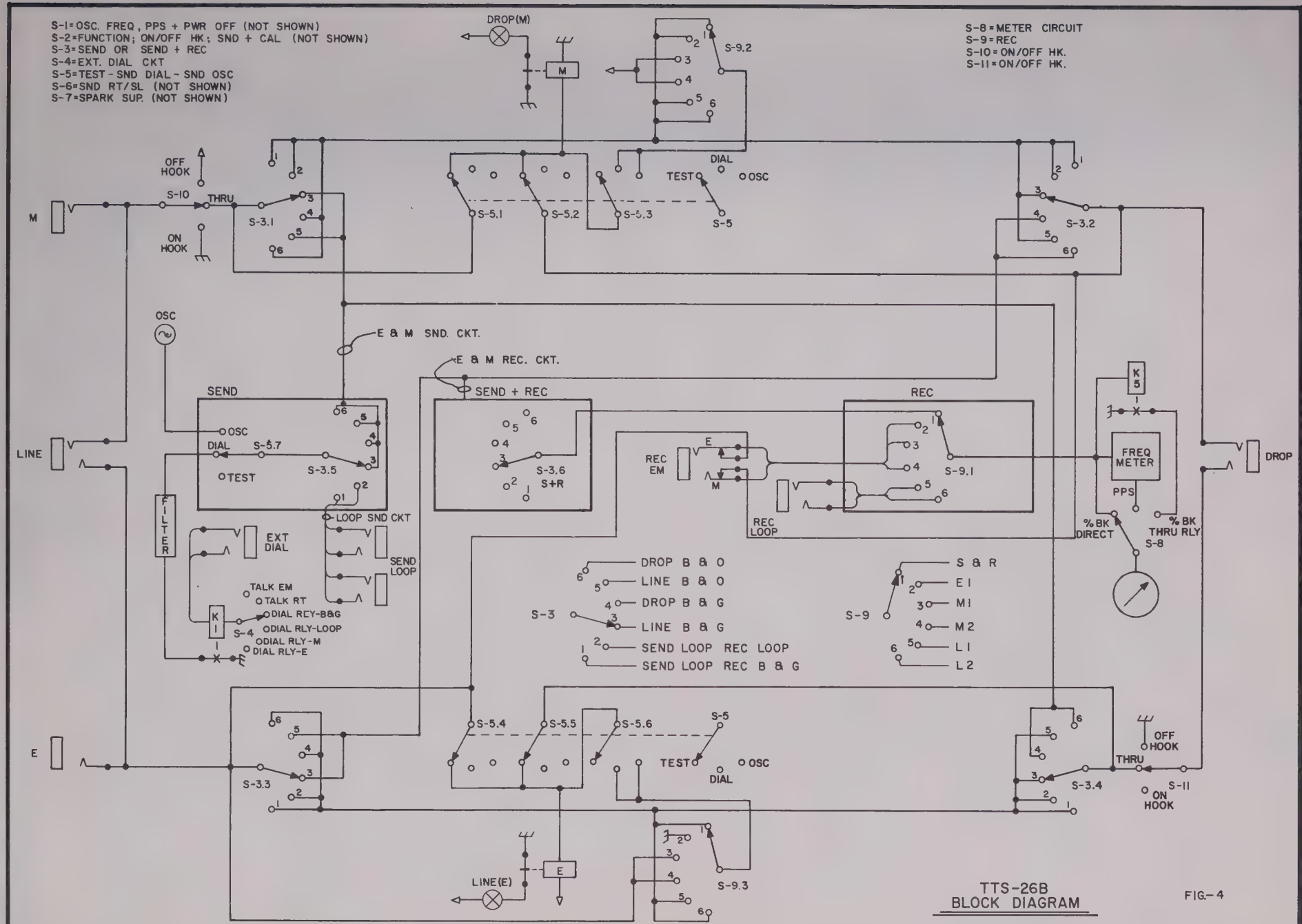
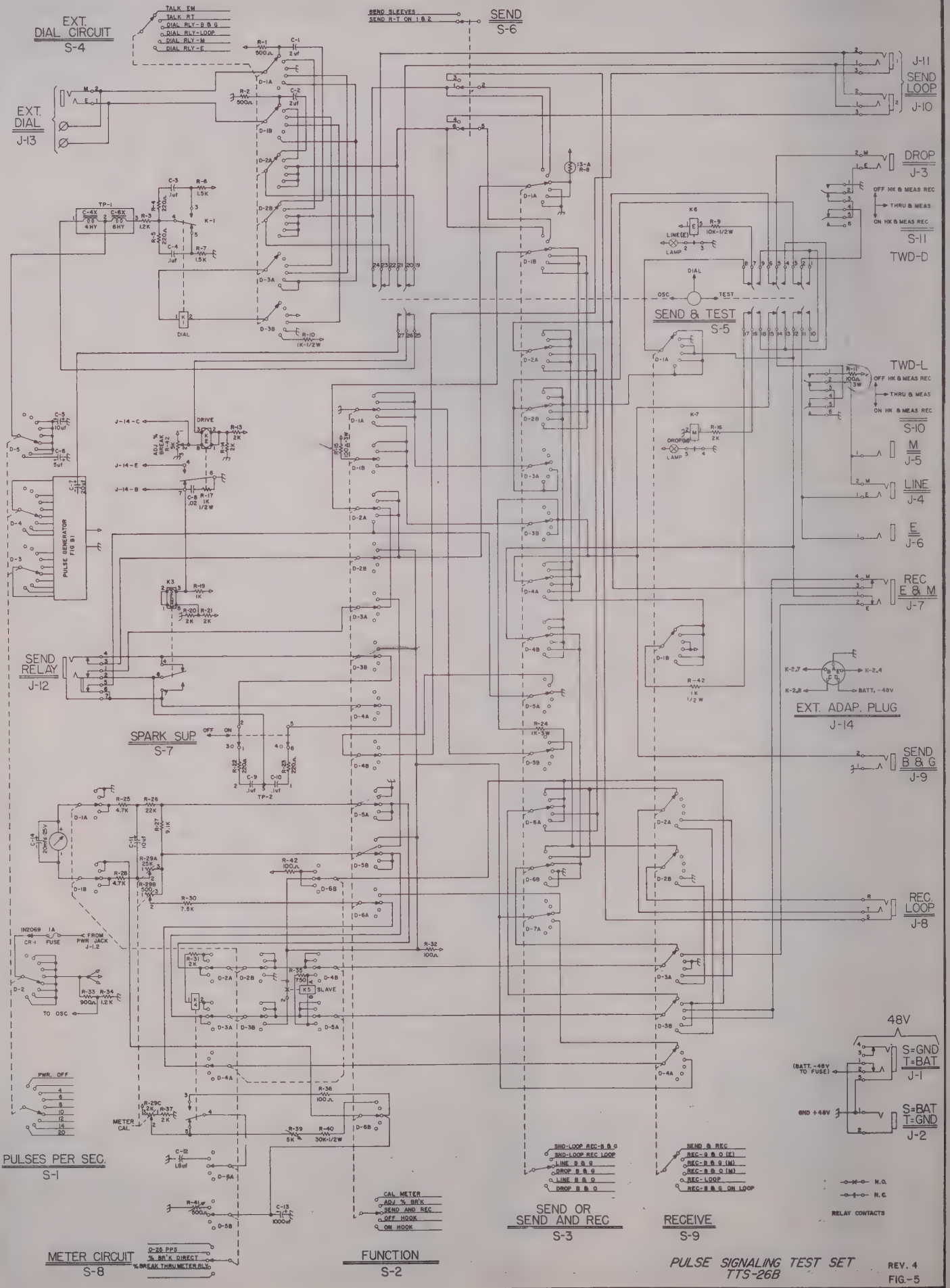

EXT. DIAL CIRCUIT SWITCH POSITION
DIAL OR TALK CIRCUIT
TALK EM
TALK EM
SEND LOOP
1
2
EXT. DIAL
EXT DIAL
-48V
TALK RT
TALK LOOP (RT)
SEND LOOP
1
2
EXT. DIAL
EXT. DIAL
DIAL RLY - B & G
EXT DIAL
EXT DIAL
K1
DRIVE
FILTER
ADJ. % BR'K
DIAL RLY - LOOP
EXT DIAL
EXT DIAL
K1
DRIVE
FILTER
ADJ. % BR'K
DIAL RLY - M
EXT DIAL
EXT DIAL
K1
DRIVE
FILTER
ADJ. % BR'K
DIAL RLY - E
EXT DIAL
EXT DIAL
K1
DRIVE
FILTER
ADJ. % BR'K
DROP
LINE
E
LINE
M
DROP
SUPERVISORY MONITOR CIRCUIT
(SEND AND TEST KEY SWITCH
IN TEST POSITION)

FIG. 3



TTS-26B
BLOCK DIAGRAM

FIG.-4


EXT. DIAL CIRCUIT S-4
TALK EM
TALK RT
DIAL RLY-B & G
DIAL RLY-LOOP
DIAL RLY-M
DIAL RLY-E
SEND SLEEVES
SEND R-T ON 1 & 2
SEND S-6
EXT. DIAL J-13
J-11 SEND LOOP J-10
DROP J-3
OFF HK & MEAS REC
THRU & MEAS
ON HK & MEAS REC
S-11
TWD-D
SEND & TEST S-5
TWD-L
S-10
M J-5
LINE J-4
E J-6
REC E & M J-7
SEND RELAY J-12
SPARK SUP S-7
EXT. ADAP. PLUG J-14
SEND B & G J-9
REC. LOOP J-8
PULSE GENERATOR FIG 81
48V
S=GND T=BAT J-1
S=BAT T=GND J-2
PULSES PER SEC. S-1
METER CIRCUIT S-8
FUNCTION S-2
SEND OR SEND AND REC S-3
RECEIVE S-9
RELAY CONTACTS
PULSE SIGNALING TEST SET TTS-26B
REV. 4
FIG.-5

APPENDIX A

A.0 OSCILLATOR-BUFFER AMPLIFIER CIRCUIT (Detailed Circuit Description)

A.01 The oscillator-buffer amplifier circuitry contained within the Model TTS 26B Pulse Signaling Test Set is normally equipped to operate on any of the following frequencies: 4, 6, 8, 10, 12, 14, or 20 cps; an additional frequency can be installed on special order. The purpose of the oscillator-buffer circuitry is to provide an output sine wave to operate the DRIVE relay. This circuit is contained on a printed board which is mounted as a sub unit on the main component board.

A.02 The output sine wave of this unit is coupled to the DRIVE relay when the SEND and TEST key switch is in the OSC position. Through the adjustment of the ADJ % BREAK control, associated with the DRIVE relay, the point on this sine wave at which the DRIVE relay will operate can be varied, thus the adjustable % break is achieved.

A.03 As transistorized circuits are used, no external power other than the 48-volt station battery is required; no warm-up period is required for this unit. The operation of this circuit is as follows:

A.04 The circuit diagram to which the following description applies is shown in Fig. B1. The location of the component part of this circuit is shown in Fig. B2.

A.05 A bridged-T type of R-C oscillator, consisting of three transistor stages, is used. The first two transistors are directly coupled from the collector of Q1 to the base of Q2. The positive feedback path is completed from the emitter of Q2 back through a blocking capacitor, C2, and a tungsten lamp, R89, utilized for level stabilization, to the emitter of Q1. A part of the emitter resistance, R15, of Q1 has been made variable to allow setting the correct amount of positive feedback necessary for stable operation.

A.06 A negative feedback, which is greater than the positive feedback, is supplied to the base of Q1 through a null selective network and an emitter follower, Q3. At its tuned frequency, the selective bridged-T null network decreases the negative feedback sufficiently to permit oscillation to occur at the desired frequency, which is determined by the R-C values employed within the network. This frequency-determining network consists of two capacitors, C4 and C5, and two selected value resistors.

A.07 Amplifier stage Q4 and the cascade emitter follower stages, Q5 and Q6, provide the necessary voltage and current gain required to operate the DRIVE relay. The output level of the amplifier stage is determined by the setting of potentiometer R19. Capacitor C7 provides DC blocking between the output emitter follower Q6 and the driven coil of the DRIVE relay.

Pulse Speed Measuring Circuit (Detailed Circuit Description)

A.08 When the METER CIRCUIT switch, S8, is in the 0-25 PPS position, a voltage directly proportional to the frequency of the signals received is generated by this pulse speed measuring circuit. This voltage is coupled to the meter, thus allowing direct reading of the speed of the signals as received by the set.

A.09 The operation of this circuit is as follows. When the METER CIRCUIT switch is in the 0-25 PPS position, the receive circuits are coupled to the coil of relay K4. Thus K4 will follow the pulses received. When K4 is in the released condition, capacitor C12 will become charged to the voltage potential appearing on the arm of the METER CAL potentiometer R29C. When K4 operates, capacitor C12 is transferred from its charging circuit to the meter and storage circuit. This storage circuit consists of capacitor C13. The energy previously stored in capacitor C12 has now been deposited in the meter storage circuit. The voltage potential to which the meter circuit can become charged is thus directly proportional to the pulsing speed of relay K4. Resistor R36 serves as a current limiting resistor for capacitor C12. Adjustable resistors R39 and R41 have been provided for calibration purposes. Resistor R40 is also part of the calibrating circuit.

APPENDIX B

B.0 MAINTENANCE AND TROUBLE SHOOTING

B.01 Apart from the normal periodic cleaning of the jack contacts, The TTS 26B does not require any routine maintenance.

B.02 If any abnormal operation occurs, it can easily be traced to one of five groups of circuits. These circuits are as follows:

1. Oscillator circuit.
2. Buffer-amplifier circuit.
3. Drive relay, send relay, and associated bias circuitry.
4. External dial and telephone set circuits.
5. Pulse speed measuring circuit.

The general location of the major component parts of the TTS 26B is shown in Figs. B2, B3, and B4.

NOTE: Unless otherwise specified, voltage or power readings apply between the point referred to and ground.

B.03 When the DRIVE relay fails to operate, the trouble is most likely to be traced to one of two causes:

1. Station battery polarity reversed.
2. Oscillator-buffer amplifier circuitry inoperative.

B.04 After the battery polarity has been checked, position the ADJ % BREAK control at its mid-position and conduct trouble shooting of the oscillator-buffer amplifier circuitry as follows.

B.05 Referring to Fig. B1, connect an oscilloscope between point A and ground. Point A is shown on Fig. B2 which is the drawing of the printed circuit board assembly. The sine wave voltage appearing between these two points should be approximately 2.5 volts peak to peak. If not, adjust potentiometer R15 to achieve this level. Turning R15 in a clockwise direction increases the positive feedback, and therefore increases the output level appearing at point A. There should be no fluctuation of the signal level at this point once the level has been adjusted to approximately 2.5 volts peak to peak. A slight amount of clipping on the peaks of this waveform need not cause alarm, as this is a normal adjustment.

B.06 If there is no voltage between point A and ground (with R15 in maximum clockwise position), check the filament of the tungsten lamp, R89, for continuity. Replace lamp if faulty. If the lamp is good, substitute transistors, starting with Q1 and ending with Q3. If trouble still prevails, check for proper DC voltages as indicated on the schematic diagram of the circuit. These voltages should be within ±10% as indicated. An open condition

of filter capacitor C8 can also cause faulty operation and should be checked through substitution.

B.07 Should the preceding steps fail to produce an output of the oscillator at point A, check other component parts contained within the oscillator circuit, such as resistors, capacitors, and the pulse frequency switching network. It is important after the correction of the trouble to readjust potentiometer R15 to produce a 2.5 peak to peak voltage indication at point A of the oscillator board.

B.08 With the oscillator operating properly, check the peak to peak voltage appearing at pin 3 of the DRIVE relay. This voltage should be in the order of 7 volts peak to peak. The exact voltage depends on the setting of the gain control, R19. The normal setting for this control is approximately in its mid-position. If normal signal voltage is not realized at this point, check the buffer-amplifier portion of the circuit. This circuit consists of transistors Q4, Q5, Q6, and their associated circuitry.

B.09 If a normal driving voltage appears at pin 2 of the DRIVE relay and trouble still prevails, the trouble will be found in either the DRIVE relay, the SEND relay, or their bias networks. When the SEND BIAS control is in its mid-position, the DC voltage between pins 1 and 8 of the DRIVE relay should be very close to 0.

B.10 Should trouble be traced to either the DRIVE or SEND relay, it is recommended that these relays be removed and tested with proper test equipment such as the Sigma 4500 Series test set or equivalent. Should these relays require readjustment, it is recommended that it be done by qualified personnel familiar with the adjustment of this type of polar relay. Standard repair kits containing two contact screws and one ferro-nickel armature are available.

External Dial and Telephone Set Circuits

B.11 Should the external dial fail to produce pulses when switch S4 is in the appropriate position for the external dial circuit used, S5 in the DIAL position, and the ADJ % BREAK control in its mid-position, trouble shooting should proceed as follows.

B.12 The various components parts associated with this circuit are shown in Figs. B3 and B4. Visual inspection of the DIAL relay will determine whether or not this relay is following the dial pulses as dialed. If this relay is not following the pulses, examine the external dial mechanism and the circuitry through the coil of this dial relay. If satisfactory operation of the dial relay has been observed, then trouble shooting should be centered around the low pass filter and its associated circuitry. While dialing, battery and ground should appear alternately

on the armature of the DRIVE relay. If not, inspect resistors R3, R4, R5, R6, R7, and capacitors C3 and C4. These alternate battery and ground pulses can be traced to the filter, over contacts 25 and 26 of S5, to pin 3 of the DRIVE relay. The filter consists of inductors C4X, C6X, and capacitors C5 and C6. The purpose of this filter is to convert the square wave as received from the DIAL relay to a waveform with sloping edges required for the proper operation of the DRIVE relay and its associated bias networks. Without the sloping waveform it would not be possible to control the % break transmitted by the set. The output waveform of this filter should approximate that of a sine wave. If capacitors C5 and C6 are suspected of being defective, these can most easily be checked through substitution. The total DC resistance reading between the armature of the DRIVE relay and the filter output as measured at terminal 25 of switch S5 should be in the order of 1700 ohms when S5 is in the oscillator position. If this reading is not observed, locate and replace the defective component. Contacts 25 and 26 of S5 should also be inspected and cleaned if necessary. For dial pulse frequencies of 4, 6, 8, 10, 12, and 14 cps, capacitor C5 is switched into the filter circuitry, and capacitor C6 is switched into the filter circuitry when dial speeds of 20 cps are used. This switching is accomplished over the PULSES PER SECOND switch, S1.

Talk Circuits

B.13 When the EXT DIAL CIRCUIT switch, S4, is in the TALK RT position and S5 is in the DIAL position, the external dial circuit is carried directly through to the T&R of SEND LOOP jacks 1 and 2. This is accomplished over contacts of S4 and S5. Should the TALK circuitry fail to operate in this position, the trouble will be traced to either the switching circuitry or the external talk mechanism.

B.14 When the EXT DIAL CIRCUIT switch is in the TALK E&M position, battery and ground are applied to the TALK circuit over resistors R1 and R2. The voltage generated by the TALK circuit is coupled to the T&R of SEND LOOP jacks 1 and 2 through DC blocking capacitors C1 and C2. Should the TALK circuit fail to function, inspect resistors R1, R2, capacitors C1, C2, the associated switch contacts of S4 and S5, and the external talk mechanism.

Pulse Speed Measuring Circuit

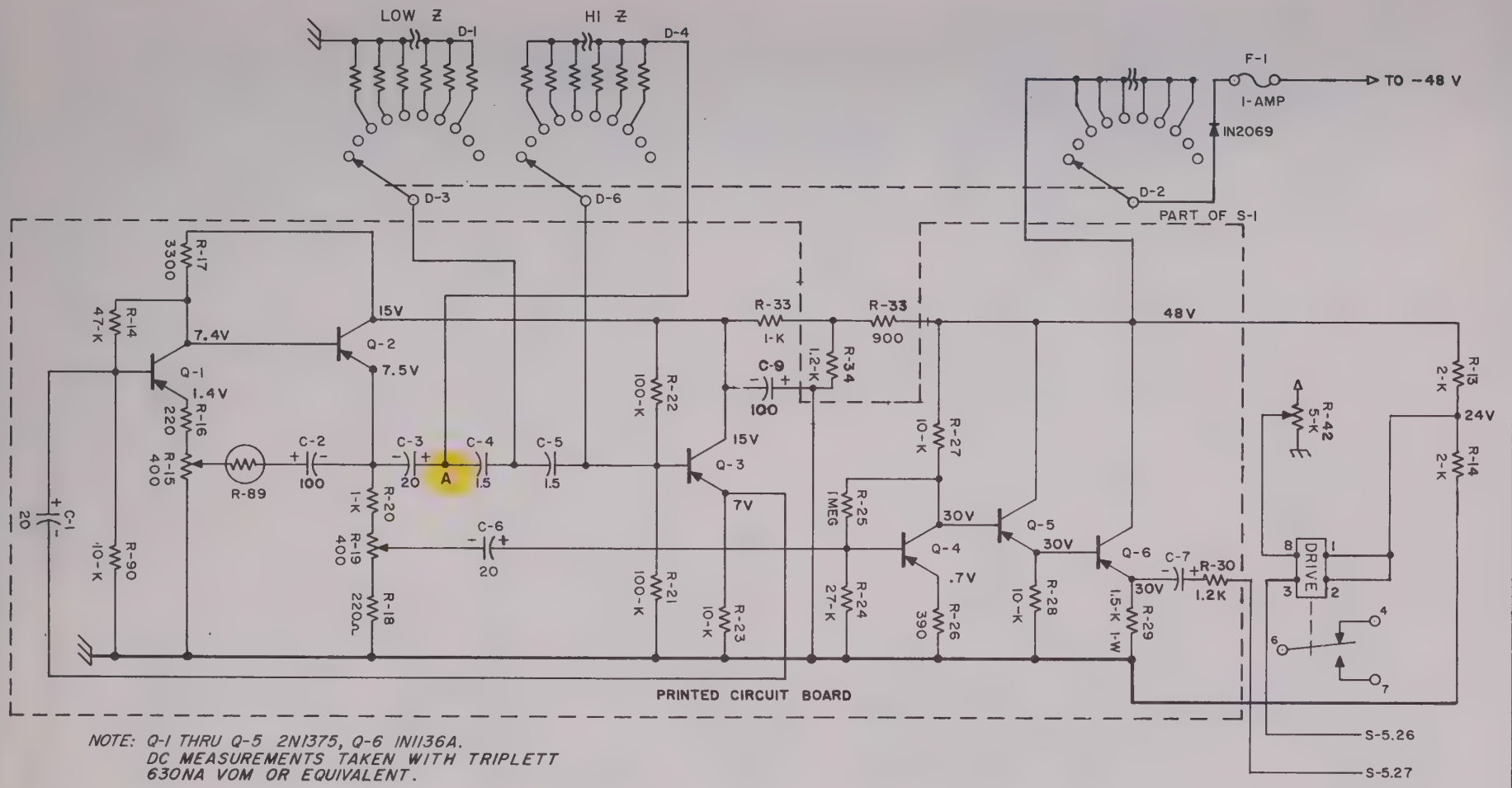
B.15 Should the pulse speed measuring circuit fail to operate, proceed as follows: Connect the receive circuitry of the TTS 26B to an external pulsing source of a known frequency, e.g. 10 pps. Calibrate the meter circuit as outlined in Section 5 of this manual. Return the METER CIRCUIT switch, S8, to its 0-25 PPS position. Relay K4 should now be following the pulses as received from the external pulsing source. When K4 is released, the voltage appearing on the arm of the calibration potentiometer, R29C, should

also appear on the armature of K3. This voltage should be in the order of approximately 30 to 35 volts. If this voltage reading cannot be obtained, then inspect the relay contacts and R29C. Resistor R37, which is also part of the meter calibration circuit, should also be checked. When relay K3 is operated, the voltage stored in capacitor C12 is then transferred to the meter and storage circuit through current limiting resistor, R36. If no meter indication is observed with the preceding circuitry operating properly, inspect capacitors C12 and C13. The trouble, if not located in the preceding operations, will then be most likely located in either the switching associated with the circuit or the meter circuit itself.

B.16 When the pulse speed circuit functions but does not indicate properly, the circuit should be recalibrated as follows: return the METER CIRCUIT switch, S8, to its % BREAK DIRECT position and perform calibration as outlined in Section 5 of this manual. After this calibration has been completed, position the METER CIRCUIT switch at its 0-25 PPS position. The meter should now read 0% break. If the meter did not read 0% break, adjust potentiometer R39 to achieve this reading. Move the FUNCTION switch to its SEND AND REC position. Connect a 10 pps pulse source into the receive circuit of the TTS 26B. The meter should indicate a speed reading of 10 pps. If not, adjust potentiometer R41 until this reading is obtained. As this is a linear circuit, no tracking adjustments are required. Should this circuit fail to track, then trouble shooting should be conducted as outlined under Paragraph B.15. After repair of the circuit, calibration should be rechecked as outlined above.

Slave Relay Circuit

B.17 When the METER CIRCUIT switch, S8, is in its % BREAK THRU RLY position, the received pulses are coupled directly to the coil of slave relay K4. The make contacts of this relay then in turn supply the pulses as received by the meter circuit. Should this circuit fail to operate, the trouble will be located either in the coil of the relay or the contacts. If the relay is found satisfactory, then the associated switching circuitry should be checked.



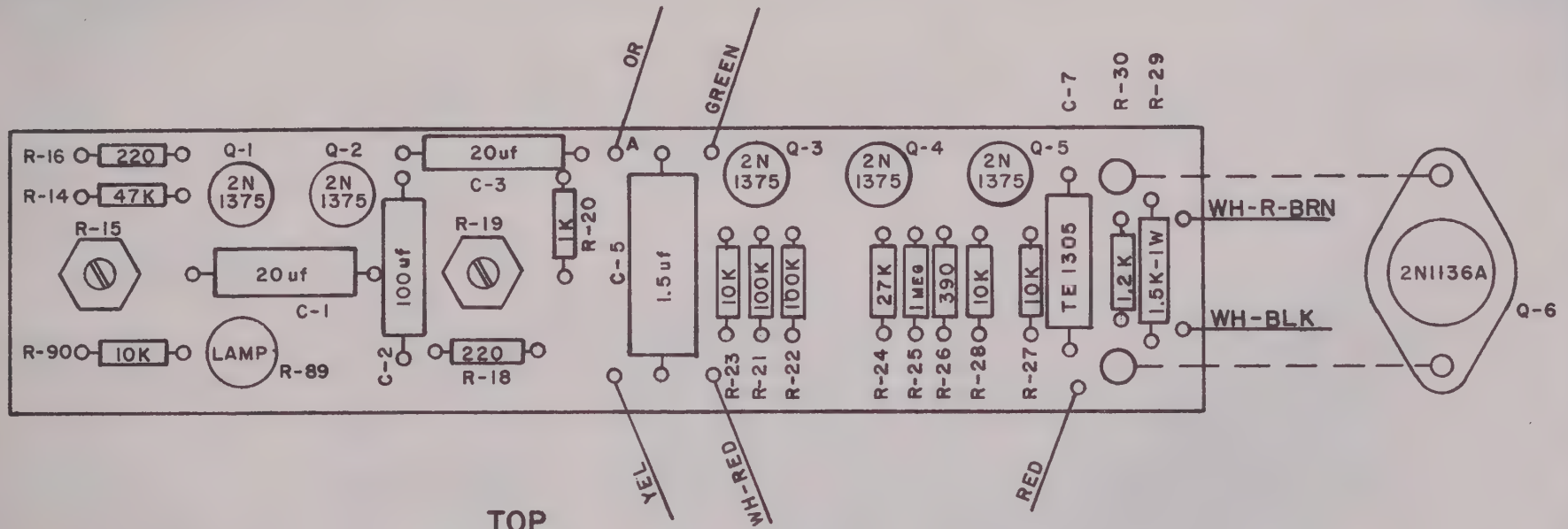
NOTE: Q-1 THRU Q-5 2N1375, Q-6 IN1136A.
DC MEASUREMENTS TAKEN WITH TRIPLETT
630NA VOM OR EQUIVALENT.

MODEL TTS-26B
PULSE GENERATOR - BIAS CIRCUIT

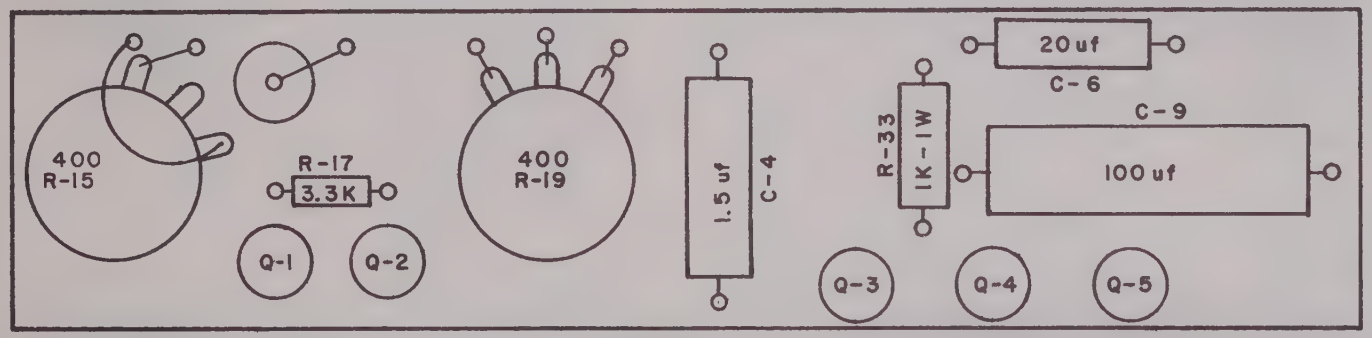
FIG. B1

REV. I

NORTHEAST ELECTRONICS CORP.
CONCORD, N.H.



TOP

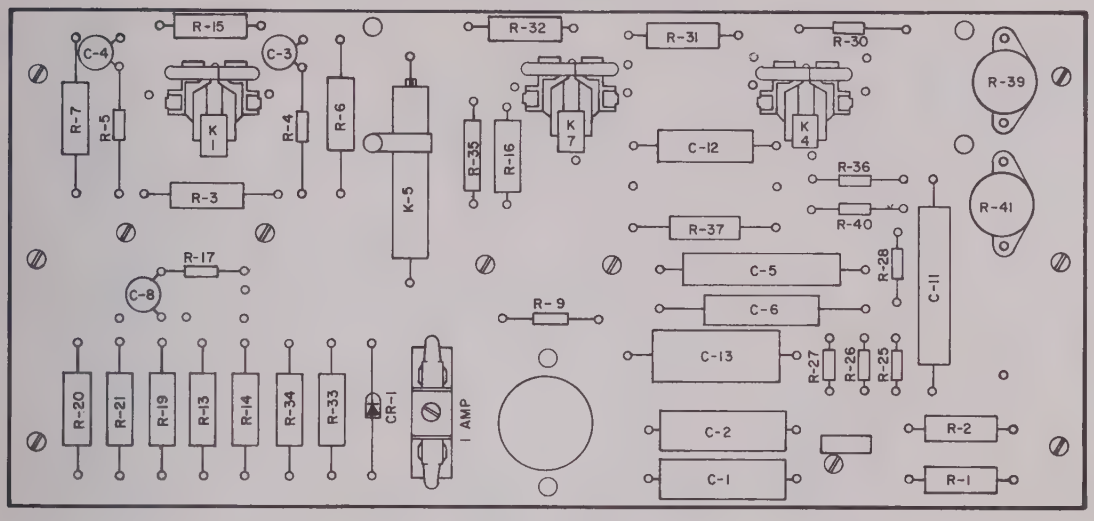


BOTTOM

NORTHEAST ELECTRONICS CORP.
CONCORD, N. H.

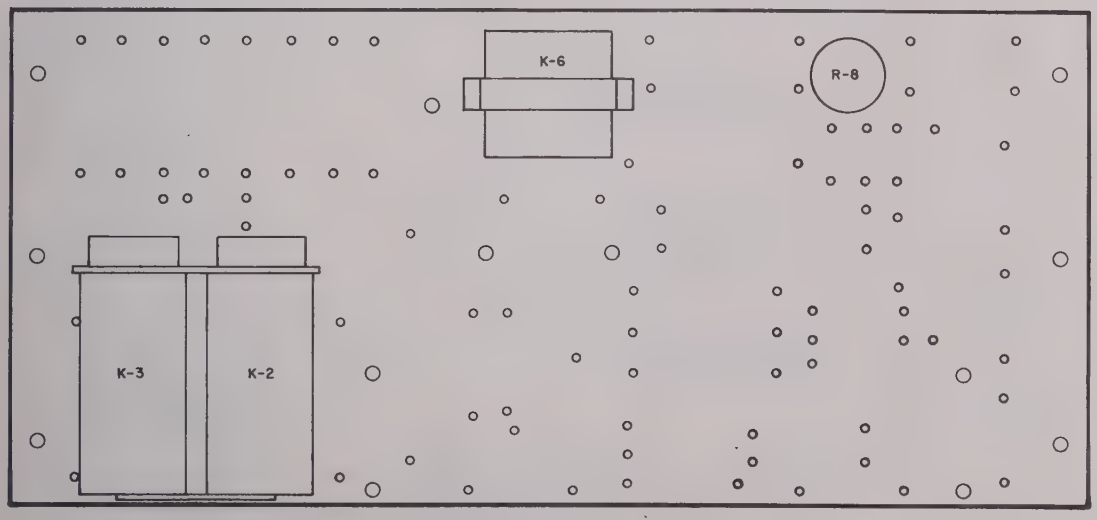
PULSE GENERATOR
PRINTED CIRCUIT BOARD
ASSEMBLY
TTS-26B

REV. 1
FIG. B2



TOP VIEW

BOTTOM VIEW

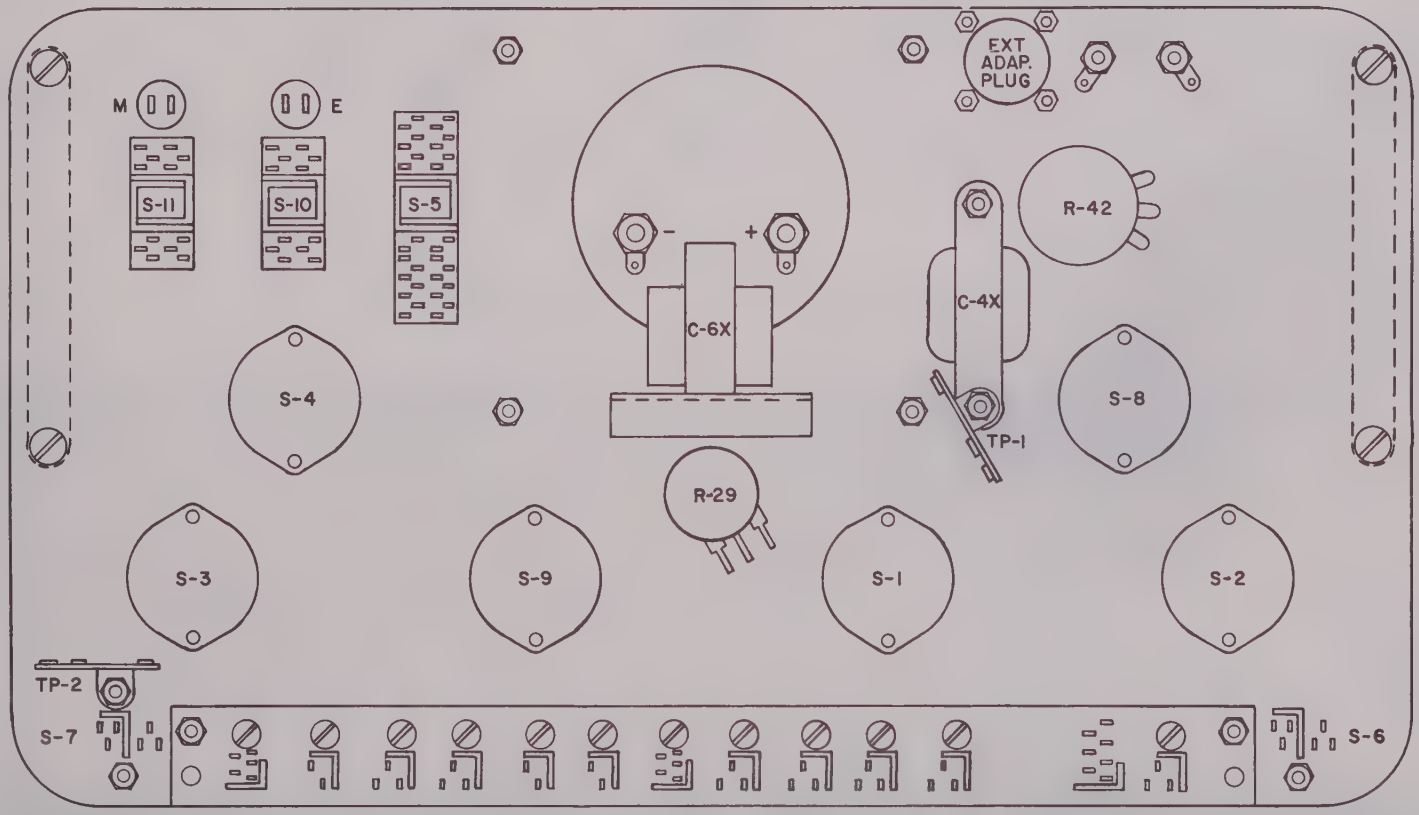


MODEL TTS-26B
COMPONENT BOARD
LAYOUT

REV. :

FIG. B3

NORTHEAST ELECTRONICS CORP.
CONCORD, N. H.



PANEL ASSEMBLY
TTS-26B

NORTHEAST ELECTRONICS CORP.
CONCORD, N. H.

FIG. B4

MODEL TTS 26B PULSE SIGNALING TEST SET
TABLE OF REPLACEABLE PARTS

Circuit Ref		Description	Mfr* & Mfr's Designation
C1	Capacitor:	fixed, paper, 2 mfd, 150 vdc	R, 121P20591R5S2
C2	Capacitor:	fixed, paper, 2 mfd, 150 vdc	R, 121P20591R5S2
C3	Capacitor:	fixed, ceramic, 0.1 mfd, 75 v	E, DDA-104
C4	Capacitor:	fixed, ceramic, 0.1 mfd, 75 v	E, DDA-104
C5	Capacitor:	fixed, electrolytic, 10 mfd, 50 vdc	R, TVA 1304
C6	Capacitor:	fixed, electrolytic, 5 mfd, 50 vdc	R, TVA 1303
C7	Capacitor:	fixed, electrolytic, 20 mfd, 50 vdc	R, TE 1305
C8	Capacitor:	fixed, ceramic,.02 mfd	E, ID-02
C9	Capacitor:	fixed, ceramic, 0.1 mfd, 75 v	E, DDA-104
C10	Capacitor:	fixed, ceramic, 0.1 mfd, 75 v	E, DDA-104
C11	Capacitor:	fixed, electrolytic, 10 mfd, 50 vdc	R, TVA 1304
C12	Capacitor:	fixed, paper, 1.5 mfd, 50 vdc	A, P1232N
C13	Capacitor:	fixed, electrolytic, 1000 mfd, 6 vdc	J, APD122
R1	Resistor:	fixed, composition, 500 ohms ±10%, 3w	K, PW-3
R2	Resistor:	fixed, composition, 500 ohms ±10%, 3 w	K, PW-3
R3	Resistor:	fixed, composition, 1.2K ±10%, 3 w	K, PW-3
R4	Resistor:	fixed, composition 220 ohms ±10%, ½w	B
R5	Resistor:	fixed, composition, 220 ohms ±10%, ½w	B
R6	Resistor:	fixed, composition, 1.5K, ±10%, 3w	K, PW-3
R7	Resistor:	fixed, composition, 1.5K, ±10%, 3w	K, PW-3
R8	Resistor:	resistance lamp	U, GB13A
R9	Resistor:	fixed, composition, 10K, ±10%, ½w	B
R10	Resistor:	fixed, composition, 1.0K, ±5%, ½w	B
R11	Resistor:	fixed, composition, 100 ohms ±10% 3w	K, PW-3

TABLE OF REPLACEABLE PARTS

Circuit Ref	Description	Mfr* & Mfr's Designation
R13	Resistor: fixed, composition, 2.0K ±10%, 3w	K, PW-3
R14	Resistor: fixed, composition, 2.0K ±10%, 3w	K, PW-3
R15	Resistor: fixed, composition, 100 ohms ±10%, 3w	K, PW-3
R16	Resistor: fixed, composition, 2.0K ±10%, 3w	K, PW-3
R17	Resistor: fixed, composition, 1.0K ±5%, ½w	B
R19	Resistor: fixed, composition, 1.0K ±10%, 3w	K,PW-3
R20	Resistor: fixed, composition, 2.0K ±10%, 3w	K, PW-3
R21	Resistor: fixed, composition, 2.0K ±10%, 3w	K, PW-3
R22	Resistor: fixed, composition, 220 ohms ±10%, ½w	B
R23	Resistor: fixed, composition, 220 ohms ±10%, ½w	B
R24	Resistor: fixed, composition, 1.0K ±10%, 3w	K, PW-3
R25	Resistor: fixed, composition, 4.7K ±10%, ½w	B
R26	Resistor: fixed, composition, 22K ±10%, ½w	B
R27	Resistor: fixed, composition, 9.1K ±5%, ½w	B
R28	Resistor: fixed, composition, 4.7K ±10%, ½w	B
R29a R29b R29c	Resistor: variable, three-ganged, wirewound, 25k, 500 ohm, 2k	G, CM31536NP
R30	Resistor: fixed, composition, 7.5K ±5%, ½w	B
R31	Resistor: fixed, composition, 2.0K ±10% 3w	K, PW-3
R32	Resistor: fixed, composition, 100 ohms ±10%, 3w	K, PW-3
R33	Resistor: fixed, composition, 900 ohms ±10%, 3w	K, PW-3
R34	Resistor: fixed, composition, 1.2K ±10%, 3w	K, PW-3
R35	Resistor: fixed, composition, 750 ohms ±10%, 5w	K, PW-5
R36	Resistor: fixed, composition, 100 ohms ±10%, ½w	B
R37	Resistor: fixed, composition, 2.0K ±10%, 3w	K, PW-3

TABLE OF REPLACEABLE PARTS

Circuit Ref	Description	Mfr* & Mfr's Designation
R38	Resistor: fixed, composition, 100 ohms ±10%, 3w	K, PW-3
R39	Resistor: variable wirewound, 5K	G, Series 39
R40	Resistor: fixed, composition, 30K ±10%, ½w	B
R41a	Resistor: variable, wirewound, 500 ohms	G, Series 39
R42	Resistor: variable, wirewound, 5K	G, CM30154NP
J1	Jack: telephone	T, 5J1192
J2	Jack: telephone	T, 5J1194MT
J3	Jack: telephone	T, 5J1329
J4	Jack: telephone	T, 5J1329
J5	Jack: telephone	T, 5J1194MT
J6	Jack: telephone	T, 5J1194MT
J7	Jack: telephone	T, 5J1192
J8	Jack: telephone	T, 5J1329
J9	Jack: telephone	T, 5J1329
J10	Jack: telephone	T, 5J1329
J11	Jack: telephone	T, 5J1329
J12	Jack: telephone	T, CMT336A
J13	Jack: telephone	T, 5J1329
T1	Inductor: 4 henry	V, C4X
T2	Inductor: 6 henry	V, C6X
S1	Switch: rotary, 9 position, 6 pole (PULSES PER SECOND)	E, PA-022-2742
S2	Switch: rotary, 5 position, 12 pole (FUNCTION)	E, PA1033
S3	Switch: rotary, 6 position, 14 pole (SEND & REC)	O, 226420-F7
S4	Switch: rotary, 6 position, 6 pole (EXT DIAL)	E, PA2027

TABLE OF REPLACEABLE PARTS

Circuit Ref	Description	Mfr* & Mfr's Designation
S5	Switch: key, telephone, 3 position (TEST DIAL OSC)	S, 173D
S6	Switch: turnbutton, 2 position (SND SL-RT)	T, 9S-1097
S7	Switch: turnbutton, 2 position (SPARK SUP)	T, 11206-L
S8	Switch: rotary, 4 position, 12 pole (METER CIRCUIT)	E, PA1033
S9	Switch: rotary, 6 position 8 pole (RECEIVE)	E, PA2027
S10	Switch: key, telephone, 3 position (ON-OFF HK LINE)	S, 173N
S11	Switch: key, telephone, 3 position (ON-OFF HK DROP)	S, 173N
K1	Relay: SPDT	W, RS5D-2500 ohms
K2	Relay: SPDT, Polar	P, 72AOZ-1000
K3	Relay: SPDT, Polar	P, 72AOZ-1000
K4	Relay: SPDT 6044-00-300 →	W, RS5D-2500 ohms
K5	Relay: SPST, Reed Type	F, CRZ-1056
K6	Relay: SPDT, 4R	P, 1200LG-SIL
K7	Relay: SPDT	W, RS5D-2500 ohms
CR1	Diode: silicon	U, 1N2069
Q1	Transistor	V, 2N1375
Q2	Transistor	V, 2N1375
Q3	Transistor	V 2N1375
Q4	Transistor	V, 2N1375
Q5	Transistor	V, 2N1375
Q6	Transistor: power	D, 2N1136A
	Meter: special 90	NEC, 2032
	Lamp: drop, pilot lamp assembly	H, 105-4428-722
	Lamp: line, pilot lamp assembly	H, 105-4428-722

TABLE OF REPLACEABLE PARTS

Circuit Ref	Description	Mfr* & Mfr's Designation
	Panel Receptacle: for external adapter	C, 165-36
	Fuse Holder	M, 357001
	Printed Circuit Board (A1117)	NEC, TTS 26B
	Socket: 5 pin, (1 per set)	C, 77-M1-5P
	Socket: 8 pin (2 per set)	C, 77-M1-8P
	Knobs: (7 per set)	L, 648-3L-BB
	Knobs:	L, 645-3-BB
	Fuse:	M, 3AG-1A

The following parts are contained on the Model TTS 26B printed circuit board:

C1	Capacitor:	fixed, electrolytic, 20 mfd, 25 vdc	J, APD-046
C2	Capacitor:	fixed, electrolytic, 100 mfd, 20 vdc	J, APD-095
C3	Capacitor:	fixed, electrolytic, 20 mfd, 25 vdc	J, APD-046
C4	Capacitor:	fixed, paper, 1.5 mfd, 50 vdc	A, P1232N
C5	Capacitor:	fixed, paper, 1.5 mfd, 50 vdc	A, P1232N
C6	Capacitor:	fixed, electrolytic, 20 mfd, 25 vdc	J, APD-046
C7	Capacitor:	fixed, electrolytic, 20 mfd, 50 vdc	R, TE 1305
C8	Capacitor:	fixed, electrolytic, 100 mfd, 50 vdc	J, APD-127
R14	Resistor:	fixed, composition, 47K ±10%, ½w	B
R15	Resistor:	variable, wirewound, 400 ohms	G, CM22425
R16	Resistor:	fixed, composition, 220 ohms ±10%, ½w	B
R17	Resistor:	fixed, composition, 3.3K ±10% ½w	B
R18	Resistor:	fixed, composition, 220 ohms ±10%, ½w	B
R19	Resistor:	variable, wirewound, 400 ohms	G, CM22425

TABLE OF REPLACEABLE PARTS

Circuit Ref	Description	Mfr* & Mfr's Designation
R20	Resistor: fixed, composition, 1.0K ±10%, ½w	B
R21	Resistor: fixed, composition, 100K ±10%, ½w	B
R22	Resistor: fixed, composition, 100K ±10%, ½w	B
R23	Resistor: fixed, composition, 10K ±10%, ½w	B
R24	Resistor: fixed, composition, 27K ±10% ½w	B
R25	Resistor: fixed, composition, 1 meg ±10% ½w	B
R26	Resistor: fixed, composition, 390 ohms ±10%, ½w	B
R27	Resistor: fixed, composition, 10K ±10%, ½w	B
R28	Resistor: fixed, composition, 10K ±10%, ½w	B
R29	Resistor: fixed, composition, 1.5K ±10% 1w	B
R30	Resistor: fixed, composition, 1.2K ±10%, ½w	B
R33	Resistor: fixed, composition, 1.0K ±10% ½w	B
R89	Lamp: tungsten (used as resistor) 4w, 120 vdc	I, T4½
R90	Resistor: fixed, composition, 10K ±10%, ½w	B

*See List of Manufacturers Code Letters for Replaceable Parts Table

LIST OF MANUFACTURERS CODE LETTERS FOR REPLACEABLE PARTS TABLE

Code Letter	Manufacturer
A	Aerovox Corporation
B	Allen-Bradley Company
C	Amphenol Manufacturing Company
D	Bendix Corporation
E	Centralab
F	C. P. Clare and Company
G	Clarostat Manufacturing Company, Inc.
H	Dialight Corporation
I	Herzog Miniature Lamp Works, Inc.
J	International Electronic Industries, Inc.
K	International Resistance Company
L	Kurz-Kasch, Inc.
M	Littlefuse, Inc.
NEC	Northeast Electronics Corporation
O	Oak Manufacturing Company
P	Sigma Instruments, Inc.
R	Sprague Electric Company
S	Stromberg-Carlson Company
T	Switchcraft, Inc.
U	Sylvania Electric Company
V	Texas Instruments, Inc.
W	Potter and Brumfield

Notes

Notes

Notes

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